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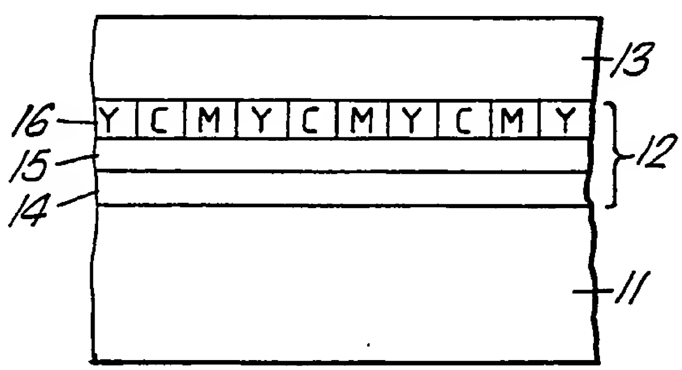

(57) Abstract

A method of generating a coloured image on a substrate (11) comprises exposing an imaging layer (12) on the substrate to a beam of radiation (7) with a predetermined wavelength, the imaging layer comprising an array of different colour imaging components constituting colour forming compounds which are colourless or transparent initially, each component being sensitive to the same predetermined wavelength such that upon exposure to the radiation beam (7) the component in the region of the imaging layer exposed to the radiation beam is activated by the beam to develop the colour corresponding to the colour component exposed to the beam. The radiation beam (7) is controlled to expose predetermined regions of the imaging layer (12) in order to generate the coloured image.

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IMPROVEMENTS RELATING TO COLOURED IMAGE GENERATION

The invention relates to methods of generating coloured images and coloured image forming members.

In conventional colour printing, a coloured image is printed by overprinting a series of colour separations. These colour separations may correspond for example to cyan, magenta, yellow (and black) or red, green, and blue. This is a relatively time consuming process involving a series of printing steps and the need to ensure accurate registration of the successive colour separations. This is a particular problem where the resultant image is relatively small as may be required for example on a securing card such as a transaction or identification card. Furthermore, in these latter applications, it is desirable to be able to generate images at a very high rate and this is conventionally achieved (with monochrome images) by making use of a laser as described, for example, in EP-A-0202811.

We have previously devised a method of generating monochrome images using a laser writing process as described in EP-A-0217517 and EP-A-0232579. Such monochrome images can be used to define security features and the like and have proved very successful. There is a need, however, to produce coloured images and one method which has been used in the past, based on conventional colour printing, involves the transfer of colours from a series of transfer sheets, one for each colour component, under the control of a heat source. Thus, the transfer sheet of a particular colour component is associated with a substrate and portions of or some of the constituents of the coloured ink on the transfer sheet are transferred to the substrate upon heating with the heat source. The transfer sheet is then removed and replaced by a second transfer sheet holding a different ink and further

selective heating carried out. This process may then be repeated for one or more further transfer sheets. Once again, this is a lengthy process and leads to a significant time for producing the images as well as having registration problems.

GB-A-2022018 illustrates a single pass, colour transfer system for generating coloured images in which the colour transfer carrier carries tiles in the form of a mosaic of different coloured materials which can be selectively transferred onto the substrate.

One of the problems with all these colour transfer techniques is that some degree of post-transfer processing is usually required. This may involve curing the transferred inks using ultraviolet in order to generate a durable finish or additional lamination steps in which further cover layers are laminated over the transferred ink to protect them.

An alternative approach is to make use of colour developing materials. Such materials are described in WO-A-8607312. In this specification a number of different arrangements are described for achieving coloured images. A primary example involves the laying down of a number of superposed layers of different colour forming components which are then imaged using a number of laser beam sources which emit laser beams of different wavelengths, each wavelength causing one of the layers to develop its colour. A modification of this arrangement is described in which the heat-sensitive compounds and associated infra-red absorbers are arranged in an array of side-by-side dots or stripes in a single recording layer. Both arrangements suffer from the disadvantage of requiring multiple laser beam sources. An alternative embodiment is described in which a single source is used but in which the imaging layers are superposed, the development of a particular imaging layer

being achieved by controlling the depth of focus of the laser beam. In practice, such control of the depth of focus is very difficult to achieve and this does not lead to a practical system which is suitable for mass producing coloured images.

In accordance with one aspect of the invention, a method of generating a coloured image on a substrate comprises exposing an imaging layer on the substrate to a beam of radiation with a predetermined wavelength, the imaging layer comprising one colour imaging component, or an array of different colour imaging components in which each component is sensitive to the same predetermined wavelength, the or each component constituting a colour forming compound which is colourless or transparent initially, the arrangement being such that upon exposure to the radiation beam the component in the region of the imaging layer exposed to the radiation beam is activated by the beam to develop the corresponding colour, wherein the radiation beam is controlled to expose predetermined regions of the imaging layer in order to generate the coloured image.

In accordance with a second aspect of the present invention, a coloured image forming member comprises a substrate; and an imaging layer comprising one colour imaging component, or an array of different colour imaging components in which each component is sensitive to the same predetermined wavelength, the or each component constituting a colour forming compound which is colourless or transparent initially, the arrangement being such that upon exposure to the radiation beam the component in the region of the imaging layer exposed to the radiation beam is activated by the beam to develop the corresponding colour.

We have devised a new method of generating a coloured image in which the full image can be generated

in a single pass or scan of the radiation beam across the substrate and imaging layer without the need for more than one radiation beam or multiple layers of colour imaging components.

In one form of the invention, the imaging layer consists of a single colour imaging component formed from a chromogenic material, the method comprising recording personalising information or other information which makes each substrate unique. This is particularly suitable in the case of a security printed item such as a plastic card.

The substrate (for example a card) in more sophisticated examples may have discrete zones which are provided with blocks of different colour imaging components so as to allow one type of information to be imaged in one colour (such as the name of the bearer of the substrate) and another type of information to be recorded in another colour. Alternatively, a single image may be recorded partially in one colour and partially in another colour. Further, the blocks of colour imaging components may be in the form of individual or grouped blocks or gross graphical patterns of colour forming compounds, including stripes of colour forming compounds having a width considerably greater than the width of the radiation beam. Alternatively, the blocks may comprise single or multiple stripes having a width similar to that of the radiation beam.

In the case of security printed items, such as security cards, true colour matching is only important if a photographic representation of the bearer of the item is to be created. Colour matching is less important where areas of text are reproduced and this offers many useful security design features for example by not using cyan, magenta and yellow.

In other examples, three or four different imaging colour components will be used to form an array, each colour component defining a respective colour of a particular set of colours. The colour sets may be cyan, magenta, yellow and black or red, green, and blue.

Various materials can be used to constitute the colour components, each component containing the same radiation absorbent material so that the components will respond to the same wavelength. Alternatively, the materials themselves could be selected to respond to the same wavelength without the addition of absorbent materials.

In one example, each colour imaging component comprises two materials which react together in response to exposure to the radiation beam to develop the appropriate colour. Preferably, in the case where the imaging layer comprises an array of different colour imaging components, one of the materials is common to all the imaging components.

In this example, the common material may be provided as a layer on the substrate the imaging layer further comprising a separation layer on the common material layer, wherein the other material of each component is provided on the separation layer. In addition, the other materials may be provided in the form of substantially parallel stripes.

In the preferred example of the imaging layer, the colour imaging components are arranged to develop a series of substantially parallel stripes. In this case, although the radiation beam could scan across the imaging layer in the direction of the stripes, it is preferred that the scanning direction is transverse, most preferably orthogonal, to the stripe direction.

The radiation beam could operate at a substantially constant intensity throughout the exposure step, although it could be modulated to different levels.

In the preferred example of the method, the substrate is exposed to the beam of radiation by causing the beam to scan across the substrate in a regular manner and causing relative movement of the substrate and radiation beam in a direction orthogonal to the scanning direction either continuously or in discrete steps. Preferably, the radiation will comprise infra-red radiation produced, for example, by a laser. Other wavelength bands, including ultra-violet may also be suitable.

It is important to be able to locate accurately the radiation beam relative to the imaging layer. One method of achieving this is to use a simple dead reckoning technique for example by detecting a leading edge of the imaging layer and thereafter assuming relative movement between the beam and imaging layer occurs in a predetermined manner.

This technique may not be sufficiently accurate for use when relatively narrow stripes are used. In this case, it is preferred to adopt the use of a low level (below the imaging threshold) auxiliary radiation beam which is reflected off the imaging layer and is modulated in response to the component on which it impinges. Alternatively, an additional feature could be included in the imaging layer detectable at wavelengths outside the operating wavelength. For example, a fluorescent material could be included in each of one type of the colour components. In a further alternative, this additional feature could be provided at regular intervals (eg. every 10 stripes) with dead reckoning being used in between.

The result of performing some of the methods could be a series of coloured regions on the substrate which are separated from each other by small distances. This could lead to an undesirable appearance in the final image. This could be dealt with by selecting suitable materials for the substrate and components such that there is some lateral diffusion of the components within the substrate after exposure to the radiation beam.

The invention is applicable to a wide variety of colour imaging applications and is particularly useful in connection with plastic card-like substrates incorporating laser-inducable colour images, such as security, identity, cheque, bank, credit and passport insert cards and laser-inducable colour copying systems. The reason for this particular advantage is that prelaminated card blanks could be manufactured for subsequent imaging through cover layer(s) without the need for further post-imaging processing.

It is particularly useful to be able to use the imaging method for adding features unique to a given individual, that is to be able to personalise the card thus making it unique. Such personal information will include portraits, signatures, names, addresses, numbers, for example bank account numbers, fingerprint patterns and the like. The information may be in graphical, alphanumeric or barcode patterns and may be in single colour or multicolour format.

Some examples of a method and member according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic block diagram of apparatus for imaging a security card;

Figure 2 is an enlarged plan of the card (not to scale);

Figure 3 is a partial cross-section through one example of the card;

Figure 4 is a partial, cross-section through another example of the card; and,

Figures 5 and 6 are schematic plans of two further examples of a security card.

The apparatus shown in Figure 1 comprises a YAG laser which generates an infrared laser beam having a wavelength of 1.064 microns. This beam is fed to a modulator 2 which modulates the beam in accordance with image modulation data supplied by a modulator control circuit 3. The modulator control circuit 3 generates control signals in response to stored data from a disc store 4. This data may define some image which is characteristic of the bearer of the security card such as his photo image, signature, name and the like. The modulated beam impinges on a card blank 5 mounted in a support 6. The support 6 can be moved transversely to the modulated beam 7 via a lead screw 8 and a motor 9 so that the card blank 5 moves in the directions of the arrows 10. The modulator 2 may also cause the beam 7 to scan across the card blank 5 in a direction orthogonal to the direction defined by the arrows 10 so that the full area of the card blank is scanned. The beam itself may be deflected by the modulator, optionally with a scanning device such as a mirror to allow coverage of a wider area.

Instead of the simple imaging arrangement shown in Figure 1, the card blank could also be imaged using an imaging system such as that described in EP-A-0202811.

The card blank 5 is formed as a laminate of plastics layers such as PVC or polyester and one example of the card construction is shown in Figure 3. The card comprises a PVC, non-transparent layer 11 having a thickness of about 650 microns on which is provided an

imaging layer 12 to be described below, the imaging layer being covered by a transparent cover layer 13 having a thickness of about 100µm. The other side of the core layer 11 may also be provided with a cover layer and additional layers (including a similar imaging layer), all the layers being laminated together (prior to imaging by the laser 1) using a suitable lamination technique such as fusion lamination. Prior to lamination, the surface of the core layer 11 which is visible through the cover layer 13 may be printed with security information, details of the issuing institution and the like.

The imaging layer 12 comprises a first layer 14 having a thickness of about 1-3 microns and containing a coupling reagent. Above this is provided a thin interfacial, polymeric (eg. PVC) membrane 15 having a thickness of less than one micron and incorporating an infrared absorbing material. On the interfacial membrane 15 is provided a series of substantially parallel stripes of colouring reagents which, when they react with the coupling reagent develop one of three colours; yellow, cyan, and magenta. This layer is indicated at 16 and also has a thickness of about 1-3 microns.

Figure 2 illustrates a number of stripes 17-24 of colouring reagents. Each stripe 17-24 has a width W of about 50 microns.

The imaging layer 12 can be fabricated by laying down the layers 14 and 15 on top of one another as shown in Figure 3 and then gravure printing the layer 16 using conventional methods. This will achieve good registration between the stripes.

In one example, the card blank 5 is mounted in the support 6 so that the laser beam 7 scans along and parallel with each stripe and is selectively modulated to cause certain portions of the stripes to develop their

respective colours. Scanning perpendicular to the stripe is achieved by suitably actuating the motor 9 which rotates the lead screw 8 in a continuous or stepwise motion. This is shown in Figure 2 where the stripes 23, 24 have been imaged and portions of these, shown by hatching, have developed their respective colours: yellow and cyan. In most cases, the data defining the image to be reproduced will define one of the colour components to be developed per pixel. Thus, a "pixel" will have a width corresponding to three stripes. In Figure 2, it may be considered that a pixel junction occurs between stripes 23 and 24.

The laser beam from the laser 1 is focussed onto the imaging layer 12, and will be absorbed by the IR absorber in the layer 15 so that the layer 15 is heated and ruptures allowing the coupling reagent in the layer 14 to react with the colouring reagent above that portion of the layer 15 which has been heated so that the appropriate colour is developed. It will be appreciated that the control of laser depth focussing in this invention is less critical than in the prior art where superposed colour layers have been employed. This gives a particular practical advantage because it reduces the otherwise very stringent flattness requirements necessary on the substrate. In particular this invention may be used with common plastic (PVC) cards which often possess minor surface undulations.

Table 1 below provides suitable examples of colouring reagents and coupling reagents.

TABLE 1

FUNCTION	GENERIC NAME	SPECIFIC CHEMICAL NAME	COLOUR OBTAINED
Colouring reagent	Leuco dye	Crystal violet Lactone	Blue
		QZ-1017*	red
		TH-107*	black
		3-(ditoluylamino)-7-(diethylamino)furane	Green
Coupling agent	Phenolic acid	Phenolphthalein Thymolphthalein	

* Trade names of Hodogaya Chemical Co.Ltd., Japan.

Examples of IR absorbers include cyanines or methines including pyrylium and thiopyrylium dyes squarylium and croconium dyes; complex thiol, mercaptol and mercaptonaphthol salts; phthalocyanines, and analogs, naphthalocyanines and their analogs; tri-arylmethane dyes; immonium and di-immonium compounds; quinones and their analogs; and azo compounds. A typical example would be
2,4-diphenyl-8-5-2,4di(pentyloxyphenyl)-6,7-dihydro-(5H)
-1-benzopyran-8-yl-2,4-pentadien-1-ylidene5,6,7,8-
tetrahydro-1-benzopyrylium perchlorate.

The laser beam generated by the laser 1 typically is focussed to a spot of about 30 microns diameter and the laser power and scanning speed are chosen such that the energy density is about 250 mj/cm². As explained above, when the laser is on, it will cause the layer 15 locally to rupture and thus cause the colour to develop

while when the laser is off, no rupture takes place and the layers 14-16 will remain transparent.

Although scanning parallel to the stripes is possible with relatively large width stripes, it would be quite difficult to align the beam with narrow stripes and thus it is preferred to scan in a direction orthogonal to the stripe direction.

In order to obtain an accurate image, it is necessary to be able to control accurately the position of the laser beam on the imaging layer 12 so that the beam modulation is kept in step with the stripes.

One possible method of achieving this would be by using dead reckoning as previously mentioned.

In view of the very small distances involved in some applications and the accurate registration involved, dead reckoning may not be sufficiently accurate. One alternative method is proposed in which in each set of three or four stripes a low visibility feature is provided which can be detected via the laser scanning optics using a secondary beam impinging on the assembly ahead of the write beam. This secondary beam may be either at write laser wavelengths (infrared) or visible wavelengths. Alternatively, it may be possible to make use of the write beam itself.

In another method a fluorescent material (UV excited and emitting detectable radiation) is incorporated in say every yellow forming stripe. The assembly is then flooded with low-level UV radiation during the writing process, and radiation emitted by the material at a point in advance of the laser spot is detected with a detector in the laser scanning optics. This could then be used to synchronise the modulation applied to the laser beam following which dead reckoning is used until the next yellow stripe is reached.

It should be understood that it may not always be necessary to incorporate a special IR absorber into the layer 15 since the material of the layer or the dyes forming the layer 16 may be inherently infra-red sensitive.

Figure 4 illustrates an alternative construction to that shown in Figure 3 in which the imaging layer 12' has a thickness of about 10 microns and is formed of stripes of respective diazonium salts which develop the three or four colours: e.g. yellow, cyan, magenta (and black). These salts are incorporated in heat sensitive micro capsules which are dispersed in a polymeric matrix containing an organic base and a suitable developing agent. The capsules are sensitised with suitable IR absorbers so that the laser beam 7 will heat the layer causing the local diazonium salt solution to be released and to interact with the developing agent to generate the colour. Once again, these stripes of diazonium salts can be printed using gravure printing and each stripe will have a width W of about 50 microns. An example of suitable microcapsules is described in US-A-3301439.

One advantage of the diazonium materials is that they are UV fixable. This means that, after imaging, an exposure to UV light would decompose the diazonium salts so that they are no longer capable of forming colours.

An example of a typical diazonium compound could be bis[2-(p-chlorophenoxy)-5-chloro-4-(N,N-dimethylamino)-phenyldiazonium] dichlorozincate.

A typical coupler or developing agent would be Naphthol ASx (N-phenyl-3-hydroxy-2-napthalenecarboxamide)

In the examples described, the stripes extend parallel with the sides of the card but in other examples (not shown) the stripes could extend diagonally with respect to the sides of the card. In further examples, the stripes could be replaced by a mosaic of tiles.

Figure 5 illustrates another example of a security card in which the imaging layer consists of two, laterally spaced, rectangular sections 25, 26 of colour forming materials of the type shown in Figure 3 or Figure 4. In the preferred arrangement, the colour forming material of the section 25 forms a different colour from that of the section 26 although this is not essential. In this example, the signature of the bearer of the card is imaged in the section 26 while a number unique to the card bearer is imaged in the section 25. Another example is shown in Figure 6 in which two sections 27, 28 of colour forming materials are provided adjacent one another in the imaging layer, the materials causing different colours to form during imaging. For example, the region 27 may generate a red and the region 28 a yellow. This will cause the bearer's signature imaged in this region of the card to have two colours.

It should be noted that the sections 25-28 shown in Figures 5 and 6 will have dimensions much larger than those of the laser beam, typically in the order of several millimetres.

Following imaging, the imaged card can be removed from the support 6 and no further processing is necessary other than any fixation.

CLAIMS

1. A method of generating a coloured image on a substrate, the method comprising exposing an imaging layer (12) on the substrate to a beam (7) of radiation with a predetermined wavelength, the imaging layer comprising one colour imaging component, or an array of different colour imaging components in which each component is sensitive to the same predetermined wavelength, the or each component constituting a colour forming compound which is colourless or transparent initially, the arrangement being such that upon exposure to the radiation beam the component in the region of the imaging layer exposed to the radiation beam is activated by the beam to develop the corresponding colour, wherein the radiation beam is controlled to expose predetermined regions of the imaging layer in order to generate the coloured image.

2. A method according to claim 1, wherein the or each colour imaging component comprises two materials which react together in response to exposure to the radiation beam to develop the appropriate colour.

3. A method according to claim 2, wherein the imaging layer comprises an array of different colour imaging components, one of the materials being common to all the imaging components.

4. A method according to claim 1, wherein the substrate is exposed to the beam of radiation by causing the beam to scan across the substrate in a regular manner and causing relative movement of the substrate and radiation beam in a direction orthogonal to the scanning direction either continuously or in discrete steps.

5. A method according to claim 1, wherein the radiation beam comprises infra-red radiation.

6. A method according to claim 1, wherein the imaging layer comprises an array of different colour imaging

components, the colour imaging components being arranged to develop stripes of colours.

7. A coloured image forming member comprising a substrate (11); and an imaging layer (12) comprising one colour imaging component, or an array of different colour imaging components in which each component is sensitive to the same predetermined wavelength, the or each component constituting a colour forming compound which is colourless or transparent initially, the arrangement being such that upon exposure to the radiation beam the component in the region of the imaging layer exposed to the radiation beam is activated by the beam to develop the corresponding colour.

8. A member according to claim 7, wherein the or each colour imaging component comprises two materials which react together in response to exposure to the radiation beam to develop the appropriate colour.

9. A member according to claim 8, wherein each component is sensitive to the same predetermined wavelength, one of the materials being common to all the imaging components.

10. A member according to claim 9, wherein the common material is provided as a layer (14) on the substrate (11) the imaging layer further comprising a separation layer (15) on the common material layer, wherein the other material of each component is provided on the separation layer.

11. A member according to claim 10, wherein the other materials are provided in the form of substantially parallel stripes (17-24).

12. A member according to claim 11, wherein at least some of the stripes include an additional fluorescent material.

13. A member according to claim 8, wherein one of the materials is a diazonium salt appropriate to the colour

be developed and in the form of heat sensitive microcapsules.

14. A security card blank comprising a member according to claim 7, wherein the substrate is laminated to at least one cover layer (13) provided on the imaging layer.

15. A coloured member comprising a member according to claim 7, which has been imaged.

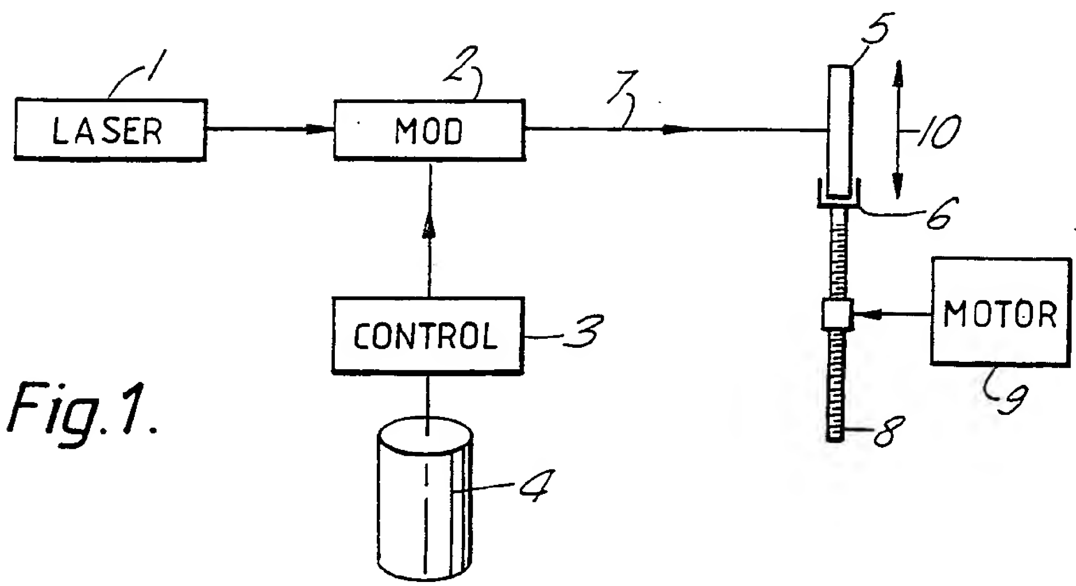

Fig.1.

Fig.2.

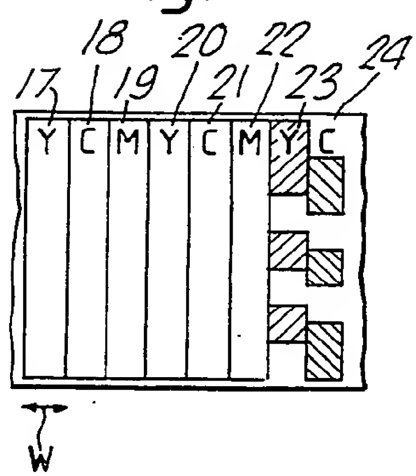

Fig.3.

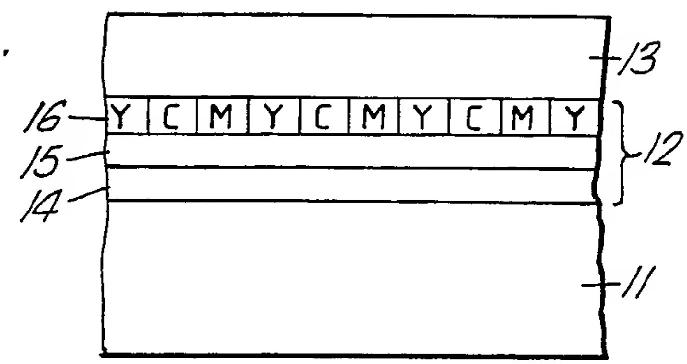

Fig.4.

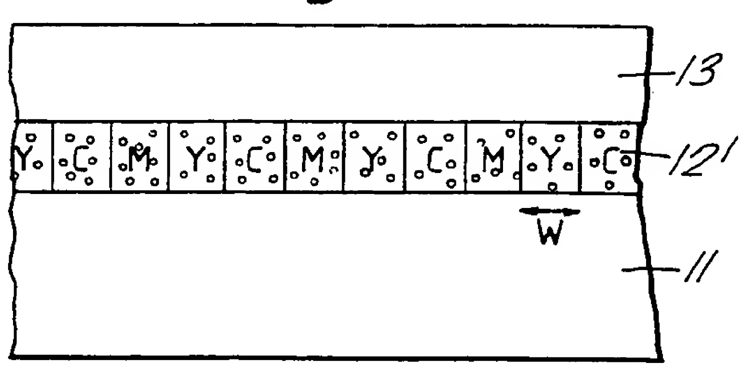

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Fig.5.

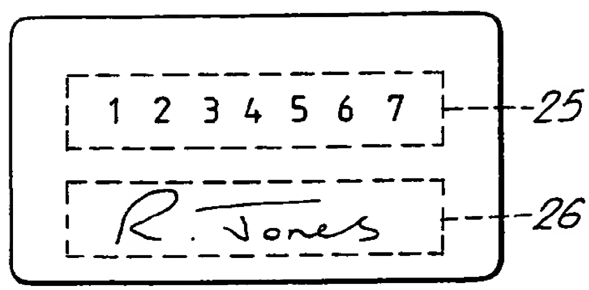
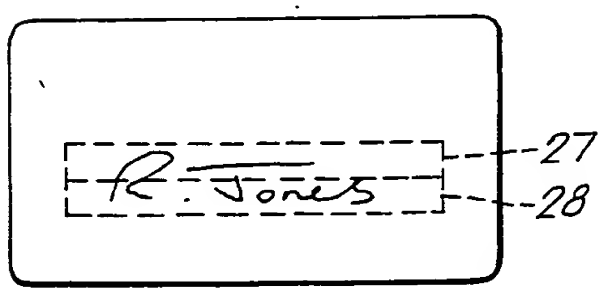


Fig.6.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/01127

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: B 41 M 5/26; H 04 N 1/46

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	B 41 M 5/00; H 04 N 1/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	GB, A, 2083726 (MINNESOTA MINING AND MANUFACTURING CO.) 24 March 1982, see page 1, lines 38-52 --	1,2,5,7-9, 13,15
Y	GB, A, 2160671 (FUJI PHOTO FILM CO. LTD) 24 December 1985, see page 1, lines 54-65	1,2,5,7-9, 13,15
A	--	10
A	GB, A, 2022018 (TEKTRONIX, INC.) 12 December 1979, see page 2, lines 33-39; page 3, lines 16-57 (cited in the application) --	3,6,11
A	EP, A, 0137559 (OCE-NEDERLAND B.V.) 17 April 1985, see page 1, lines 6-14	4

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
31st March 1989	24.04.89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 8801127
SA 26156

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 13/04/89
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2083726	24-03-82	None	
GB-A- 2160671	24-12-85	JP-A- 60242093	02-12-85
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